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CORRECTIVE ACTION PLAN FOR ZONE E SITE 27-BUILDING 221 UNDERGROUND
STORAGE TANK 221-1 (UST221-1) WITH TRANSMITTAL CNC CHARLESTON SC
1/1/2001
J A JONES ENVIRONMENTAL SERVICES

**CORRECTIVE ACTION PLAN
FOR
ZONE E/ SITE 27-BUILDING 221
UNDERGROUND STORAGE TANK 221-1
SITE No: 17686**

**Charleston Naval Complex
Charleston, South Carolina**

**SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND**

Contract Number N62467-99-C-0960

January 2001



JA Jones Environmental Services

TRANSMITTAL FORM

Project:						
Charleston Naval Shipyard						
DO Title:						
Delivery Order '012						
DO Project Location:						
Charleston Naval Complex						
Date:	25-Jan-01		To:	Chuck Williams		
Contract Number :				SCDHEC		
				2600 Bull Street		
Delivery Order Number				Columbia , SC 29201-1708		
	012			803-898-4339		
File Number				From: Brian R. Crawford		
	0			J.A. Jones Environmental Services 1849 Avenue F North Charleston, South Carolina 29405 (843) 740-2780		
JAJ Subcontract Number			Subcontractor/Supplier/Manufacturer:		Transmitted for:	
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Enclosed	X	Original				
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Mail						
Other						
Other						
CC:				Signed:		
Project File				BRC		
Gary Foster						
Gabe Magwood						
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26 April 2000

2600 Bull Street
Columbia, SC 29201-1708

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Department of the Navy
Southern Division NFEC
P.O. Box 190010
North Charleston, SC 29419-9010
Attention: Mr. Gabriel Magwood

Re: Final Assessment Report dated 09 March 2000
Zone E/Site 27-Building 221 (Site Identification # 17686)
Charleston Naval Complex/Charleston Naval Base
Charleston, SC
Charleston County

Dear Mr. Magwood:

The author has completed technical review of the referenced document. As submitted, the report provides a narrative and summary of previous assessment activities and analytical results from additional sampling conducted to establish the environmental fate of suspected contamination at the subject property. Analytical results provided indicate that concentrations of PAH and metal compound(s) were reported in groundwater samples obtained at the subject site. The reported concentrations exceed the RBSL (Risk-Based Screening Levels, SCDHEC *Risk-Based Corrective Action for Petroleum Releases*, 5 January 1998), proposed RBC (Risk-Based Concentrations for Residential Soils, EPA Region III Risk-Based Concentrations Table, 07 October 1999) and/or established groundwater MCLs (maximum contaminant levels) and/or established health advisories. Available analytical data and applied interpretations appear to indicate that a reasonable delineation and characterization of the extent and severity of soil and groundwater contamination have been developed for the Building 221 site, with the exception noted below. This information and data were then utilized to develop SSTL (site specific target levels) for CoC (contaminants of concern) in evidential discussion(s) for consideration of employing active remediation (groundwater) at the subject site.

One (1) soil sample collected from boring CNC27-B01 was analyzed (mobile laboratory) for BTEX compounds, naphthalene and DRO (diesel range organics), with no detections of compounds noted. This boring was selected based on predetermined criteria (section 2.3.2) which included OVA response. Boring logs indicate OVA response of > 5000 ppm with carbon filter this boring. The author is concerned that existing sampling regimen at waste oil vessels may not be sufficient to identify all contaminants potentially associated with these sites. In particular, the OVA response may be directly related to the presense of chlorinated volatile compounds (i.e., solvents for degreasing) which have not been analyzed for to date. With consideration to the above, the author requests the facility to reevaluate current assessment


Charleston Naval Complex/Charleston Naval Base
26 April 2000
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strategies for waste oil tanks and incorporate sampling and analysis for VOC (volatile organic compounds) compounds in addition to those compounds typically associated with petroleum hydrocarbons. Further, the facility is requested to identify all waste oil sites which have been assessed to date and provide reasonable justification to the Department that existing data is sufficient to adequately and accurately characterize these sites.

The facility is requested to develop an appropriate response to the above comment, including proposed sampling and reporting schedule, if appropriate, and submit same to my attention by 31 May 2000.

Should you have any questions please contact me at (803) 898-3559.

Sincerely,


Paul L. Bristol, Hydrogeologist
Groundwater Quality Section
Bureau of Water

cc: Trident District EQC

**CORRECTIVE ACTION PLAN
FOR
ZONE E/ SITE 27-BUILDING 221
UNDERGROUND STORAGE TANK 221-1
SITE No: 17686**

**Charleston Naval Complex
Charleston, South Carolina**

**Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
Charleston, South Carolina 29406**



Submitted by:



CH2MHILL

**CH2M-JONES, LLC.
115 Perimeter Center Place NE
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Atlanta, Georgia 30346-1278**

Contract Number: N62467-99-C-0960

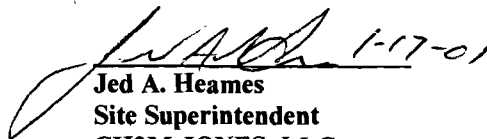
January 2001

PREPARED BY:


1-15-01

**Brian R. Crawford
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APPROVED BY:


1-17-01

**Jed A. Heames
Site Superintendent
CH2M-JONES, LLC.**

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ACRONYMS AND ABBREVIATIONS

bls	below land surface
CAP	Corrective Action Plan
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene Isomers
CNC	Charleston Naval Complex
CSAP	Comprehensive Sampling and Analysis Plan
EDB	ethyl benzene
EISOPQAM	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
EPA	Environmental Protection Agency
ft	foot
mg/kg	microgram per kilogram
mg/L	microgram per liter
MtBE	methyl tertiary butyl ether
OVA	Organic Vapor Analyzer
PAHs	polynuclear areomatic hydrocarbons
QA	Quality Assurance
QC	Quality Control
RBSL	Risk-Based Screening Level
RDA	Redevelopment Authority
SAP	Sampling and Analysis Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SOUTHDIV	Southern Division Naval Facilities Engineering Command

SSTL	Site-Specific Target Level
TTNUS	Tetra Tech NUS
UST	Underground Storage Tank

1.0 INTRODUCTION

This Corrective Action Plan (CAP) has been prepared by CH2M-JONES, LLC. The plan is designed for Zone E/ Site 27-Building 221; Underground Storage Tank (UST) 221-1 located at the Charleston Naval Complex (CNC), Charleston, South Carolina.

The South Carolina Department of Health and Environmental Control (SCDHEC) has designated this site as Identification Number: 17686. This SAP provides methods to further evaluate the applicability of intrinsic remediation and monitoring well abandonment as a corrective action for UST 221-1 in accordance with SCDHEC Corrective Action Guidance, June 1997.

1.1 General Site Description

The CNC is located in the city of North Charleston, on the west bank of the Cooper River in Charleston County, South Carolina as shown in Figure 1. This installation consists of two major areas: an undeveloped dredge materials area on the east bank of the Cooper River on Daniel Island in Berkley County, and a developed area on the west bank of the Cooper River. The developed portion of the base is on the peninsula bounded on the west by the Ashley River and on the east by the Cooper River. The site is located within the developed portion of the base.

The area surrounding CNC is “mature urban”, having long been developed with commercial, industrial, and residential land use. Commercial areas are primarily west of CNC; industrial areas are primarily to the north of the base along Shipyard Creek.

1.2 Objective

Based on the final assessment completed by TTNUS in 2000, the chemicals of concern (COC) is Naphthalene in one groundwater sample at a level of 17 $\mu\text{g/L}$, Lead in three groundwater samples one which was a duplicate, at levels of 42.5 $\mu\text{g/L}$, Duplicate 17.5 $\mu\text{g/L}$, and 675.0 $\mu\text{g/L}$, and total Chromium in one groundwater sample at a level of 133 $\mu\text{g/L}$ located at the site (see Tables 1 thru 9 in Section 6.0 of this plan). It should be noted that at no time did the prior sampling events include both total and dissolved metals. It is CH2M-Jones, LLC's objective to resample for total and dissolved metals for the eight metals listed in Section 5.1 of this document in order to determine that the high levels of metals reported in previous sampling events are contributed to a turbidity/ silt existence instead of an actual metals in groundwater issue.

The following table shows the calculated RBSLs for each pathway and the SSTL for the construction worker using the levels of metals which; were not filtered (TTNUS, 2000).

Chemical of Concern	Dermal RBSL, mg/L	Incidental Ingestion RBSL mg/L	Inhalation RBSL, mg/L	SSTL (Minimum RBSL mg/L)	Maximum Source Concentration Source, mg/L	Exceeds SSTL
Naphthalene	1.63	1135.56	2.63	1.63	0.017	No
Lead*	NA	NA	NA	0.19*	0.675	Yes
Total Chromium	2.37	85.17	NA	2.37	0.133	No

* A construction worker specific RBSL could not be calculated for lead because of unavailable data and the characteristics of lead being non-volatizing and non-absorbing. The above SSTL for lead was obtained from the state of Michigan's Generic Cleanup Criteria and Screening Levels.

2.0 RECEPTOR SURVEY

A receptor survey of the site vicinity was conducted by TTNUS to identify potential receptors for petroleum hydrocarbon contamination. Figure 2 depicts the public utilities located within 250 feet of the former UST 221-1 study area. Specific information concerning the depth of utilities below land surface (bls) is currently unavailable, however, utilities at this site generally are between 2 to 6 feet (ft) bls. The following utility receptors were located:

UTILITY	ON-SITE OR DISTANCE/ DIRECTION FROM SITE	DEPTH TO UTILITY
Gas	none	2-6-ft bls
Electrical	North and south of Bldg 221	2-6-ft bls
Sewer	North of Bldg 221	2-6-ft bls
Storm Drain	North, west and east of Bldg 221	2-6-ft bls
Water	North, west, and south of Bldg 221	2-6-ft bls

According to the RA report completed by TTNUS, a survey of groundwater users within a 7-mile radius of CNC was conducted by the South Carolina Water Resources Commission to ascertain the extent of any shallow groundwater usage. Results of the water use investigation revealed that no drinking water wells, which utilize the shallow aquifer, are located within a 4 mile radius of CNC. Irrigation wells are not identified within 1,000 feet of the site. Numerous monitoring wells are located within 1,000 feet of the site. The nearest surface water body to the site is the Cooper River located approximately 150 feet south from the site (TTNUS, 2000).

2.1 Fate and Transport Modeling

The Dominico model was the fate and transport model used to determine groundwater site-specific target levels (SSTLs) in the risk analysis. The Dominico dilution/attenuation model is presented in the SCDHEC guidance document, *South Carolina Risk-Based Corrective Action for Petroleum Releases* (SCDHEC, 1988). This model is very conservative in that it assumes an infinite mass, aerial source condition through which groundwater flows. The model incorporates biological decay effects through a first-order decay process; however, this mechanism was ignored because SCDHEC guidance specifies that the decay rate must be assumed to be zero if site-specific decay rates have not been determined.

The impacted groundwater source area was modeled as 50 feet (15 meters) wide and 6.56 feet (2 meters) deep; these values are conservative defaults suggested by the American Society for testing and Materials (ASTM) *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM 1997). The maximum source concentrations are assumed to exist throughout the source area, further compounding the conservatism of the estimate.

3.0 PROPOSED REMEDIATION TECHNOLOGY

In the RA completed by TTNUS in 1999, several analysis were collected at Site 27, Building 221. On September 23, 1999 a total of six monitoring wells were sampled for benzene, toluene, ethyl benzene, and xylenes (BTEX), methyl tertiary butyl ether (MtBE), ethylene dibromide (EDB or 1,2-dibromoethane), naphthalene using method 8260, Polynuclear Areomatic Hydrocarbons (PAHs) using method 8270, eight specific metals (lead, arsenic, barium, cadmium, chromium, mercury, selenium, and silver) using methods approved in the SCDHEC document *Underground Storage Tank Assessment Guidelines for Permanent Closure and Change-In-Service, July, 1998*. In addition, groundwater samples were collected from three wells and analyzed for the following natural attenuation parameters: dissolved oxygen, alkalinity, carbon dioxide, manganese, ferrous iron, nitrate, sulfide, nitrogen/nitrate, sulfate and methane.

Because the prior sampling events did not filter metals before sampling, CH2M-Jones will be sampling for dissolved (filtered) and total metals in order to eliminate turbidity as a being a contributor to the high levels of metals found in the RA. It is possible that the levels of metals found in the RA were contributed to the large amount of solids found in this area of the Naval Base. In the event that the analytical results for the total and filtered are above the RBSLs, CH2M-JONES, LLC will consider other active measures for this site.

After review of the RA's natural attenuation parameters, it has been determined that natural attenuation is occurring at the site (refer to Figure 3 in Section 6.0). An intrinsic remediation with a monitoring period of 9 months will be performed at the site. The monitoring program will consist of sampling initially seven monitoring wells adjacent to the source point, and only sampling three selected wells thereafter. The proposed monitoring program is described in detail in sections 4.0 and 5.0 of this plan. As stated in section 2.1, the known contaminants are naphthalene, lead, and chromium. All other contaminants are below the RBSLs. In addition to sampling the known contaminants, several other intrinsic parameters will be measured to support intrinsic biodegradation/ natural attenuation. As a general guidance, biodegradation of petroleum hydrocarbons most commonly occurs by means of aerobic, nitrate-reducing, Fe(III)-reducing, sulfate-reducing, and methanogenic respiration as noted in the tables on page 3-2 (Parsons Engineering Science, Inc. and USGS, 1998).

**Trends in Contaminant, Electron Acceptor, and
Metabolic Byproduct Concentrations During Biodegradation**

Analyte	Trend in Analyte Concentrations During Biodegradation	Terminal Electron Accepting Process Causing Trend
Petroleum Hydrocarbons	Decrease	Aerobic respiration, denitrification, Mn (IV) reduction, Fe (III) reduction, sulfate reduction, methanogenesis
Highly Chlorinated Solvents and Daughter Products	Parent compound concentrations decrease, daughter products increase initially and then may decrease	Reductive dechlorination and cometabolic oxidation
Lightly Chlorinated Products	Decrease	Aerobic respiration and Fe (III) reduction (direct oxidation) and cometabolism (indirect oxidation)
Dissolved Oxygen	Decrease	Aerobic respiration
Nitrate	Decrease	Denitrification
Mn (II)	Increase	Mn (IV) reduction
Fe (II)	Increase	Fe (III) reduction
Sulfate	Decrease	Sulfate reduction
Methane	Increase	methanogenesis
Chloride	Increase	Reductive dechlorination or direct oxidation of chlorinated compound
Oxidation/ Reduction Potential	Decrease	Aerobic respiration, denitrification, Mn (IV) reduction, Fe (III) reduction, sulfate reduction, methanogenesis and halorespiration
Dissolved Inorganic Carbon	Increase	Aerobic respiration, denitrification, Fe (III) reduction, and sulfate reduction

4.0 MONITORING WELL INSTALLATION AND ABANDONMENT

4.1 Monitoring Well Installation

Because of the amount of monitoring wells located in and around this site, no monitoring wells will be installed as part of this plan.

4.2 Monitoring Well Abandonment

All monitoring wells will be abandoned at Building 221 after receiving a No Further Action status from SCDHEC. The well abandonment procedures will follow the South Carolina Well Standards and Regulations R.61-71. The well abandonment will include grouting wells, removing stick-ups and removing all guard posts.

4.3 Surveying

Because no monitoring wells will be installed at this site, a new survey will not be conducted.

4.4 Equipment Decontamination

All drilling equipment, augers, well casing and screens, and soil and groundwater sampling equipment involved in field sampling activities will be decontaminated according to the Environmental Protection Agencies (EPA) “ Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM).

5.0 PROPOSED GROUDWATER MONITORING PROGRAM

5.1 Monitoring Frequency and Reporting

Sampling date or (Quarter)	Monitoring Well	Field Measures	Laboratory Analytical
First quarter ¹ 2001 or as soon as DHEC approval	CNC27X-MW01, CNC27X-MW03, CNC27X-MW04, CNC27X-MW04D CNC27X-MW05, CNC27X-MW07	T°, pH, DO, Conductivity, Depth to water, Total depth, Turbidity	Naphthalene 8260 Eight specific metals: total and dissolved lead, arsenic, cadmium, chromium, mercury, selenium, and silver In addition MW3, MW5, and MW1 will be sampled for nitrate, sulfate, alkalinity, Fe II, Fe III, and methane
Second quarter ² 2001	CNC27X-MW03, CNC27X-MW05, CNC27X-MW01	T°, pH, DO, Conductivity, Depth to water, Total depth, Turbidity	Naphthalene 8260 Eight specific metals: total and dissolved lead, arsenic, cadmium, chromium, mercury, selenium, and silver nitrate, sulfate, alkalinity, Fe II, Fe III, and methane
Third quarter ² 2001 * if needed*	CNC27X-MW03, CNC27X-MW05, CNC27X-MW01	T°, pH, DO, Conductivity, Depth to water, Total depth, Turbidity	Naphthalene 8260 Eight specific metals: total and dissolved lead, arsenic, cadmium, chromium, mercury, selenium, and silver nitrate, sulfate, alkalinity, Fe II, Fe III, and methane

1. First quarter is defined as January, February , March.
2. Second quarter is defined as April, May , June.
3. Third quarter is defined as July, August, September.

NOTES: * Third quarter will be determined at time of sampling. If first and second quarters show COCs below SSTLs, NFA will be suggested.

- **Frequency:** Initially all monitoring wells at this site will be sampled. Thereafter, groundwater samples will be collected from wells MW-03, MW-05 and MW-07.
- **Reporting:** Semi-annual groundwater monitoring reports will be submitted to SCDHEC.

Included in the semi-annual reports will be field and analytical information from the certified laboratory indicating well numbers, analytical methods used, date sampled, date analyzed, and method detection limits.

At the end of the third quarter period, (or as necessary) a performance evaluation will be submitted to SCDHEC providing the effectiveness of the intrinsic biodegradation/natural attenuation occurring and any recommendations for the site if needed. Because the prior sampling events did not filter metals before sampling, CH2M-Jones will be sampling for dissolved (filtered) and total metals in order to eliminate turbidity as a being a contributor to the high levels of metals found in the RA. It is possible that the levels of metals found in the RA were contributed to the large amount of solids found in this area of the Naval Base.

- **Groundwater Sampling**

Prior to any groundwater sampling, each well will be measured for water levels and total depth and each well will be purged in accordance the EPA EISOPQAM.

5.2 Analytical Parameters

The following constituents will be analyzed for each groundwater sample:

- Naphthalene using method 8260.
- Eight specific metals (Total and Dissolved metals): Lead, Arsenic, Barium, Cadmium, Chromium, Mercury, Selenium, and Silver

The following parameters will be analyzed in order to evaluate the effectiveness of intrinsic remediation:

- Nitrate (NO^{-3})
- Sulfate (SO^{-4})
- Total iron
- Dissolved iron
- Methane (CH_4)
- Alkalinity

5.3 Field Measurements

The following parameters will be sampled in the field:

- Temperature
- pH
- Dissolved Oxygen
- Depth to water table
- Depth of well
- Turbidity
- Specific Conductance

Field measurements will be recorded in the field book and in field forms.

5.4 Groundwater Level Measurements

Groundwater measurements will be taken from all monitoring wells at the site during each sampling event. All water level measurements will be taken on the same day as anticipated sampling.

Measurements will be taken with an electrical water level meter or interface probe if floating product is present using the highest part of the top of the casing as a reference point for determining depths to water and total depths. Water level measurements will be recorded to the nearest 0.01-foot in the field book.

5.5 Sample Handling

Field procedures and groundwater analysis will follow standard procedures found in the approved Corrective Action Sampling and Analysis Plan (CSAP) portion of the RFI Work Plan (Ensafe, Inc./ Allen & Hoshall, 1996). The CSAP outlines all monitoring procedures to be performed in during the investigation in order to characterize the environmental setting, source, and releases of hazardous constituents. In addition, the CSAP includes the Quality Assurance plan and Data Management Plan to verify that all information and data are valid and properly documented. Unless otherwise noted, the sampling strategy and procedures will be performed in accordance with the EPA Environmental Services Division

Sample Handling will be conducted in accordance with the following references:

EPA EISOPQAM (EPA May, 1996)

Comprehensive Sampling and Analysis Plan(Ensafe/Allen & Hoshall July, 1996)

5.6 Sample Packing and Shipping

The following forms will be compiled to complete the packing/shipping process:

- Sample labels
- Chain-of-custody labels
- Appropriate labels applied to shipping coolers
- Chain-of-custody forms
- Federal express air bills

5.7 Quality Check

Quality Control (QC) samples will be collected during sampling events. QC samples may include field blanks, field duplicates, and trip blanks. Definitions of each can be found below as described by the EISOPQAM:

- **Field Blank:** a sample collected using organic-free water, which has been run over/through sample collection equipment. These samples are used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. Equipment field blanks are often associated with collecting rinse blanks of equipment that has been field cleaned.
- **Field Duplicates:** Two or more samples collected from a common source. The purpose of a duplicate sample is to estimate the variability of a given characteristic or contamination associated with a population.
- **Trip Blank:** A sample, which is prepared prior to the sampling event in the actual container and is stored with the investigative samples throughout the sampling event. They are often packaged for shipment with the other samples and submitted for analysis. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks are used to determine if samples were contaminated during storage and/or transportation back to the laboratory (a measure of sample handling variability resulting in positive bias in contaminant concentration). If samples are to be shipped, trip blanks are to be provided with each shipment but not for each cooler.

5.8 Control Limits

Analysis	Control Parameter	Control Limit	Corrective Action
Air Monitoring	Check Calibration of OVA daily	Calibrate to manufactures specifications	Recalibrate. If unable to calibrate, replace.
pH of water	Continuing calibration check of pH 7.0 buffer	pH= 7.0	Recalibrate. If unable to calibrate, replace electrode.
Specific Conductance of water	Continuing calibration check of standard solution	> 1% of standard	Recalibrate.

5.9 Record keeping

In addition to records kept in logbooks, forms will be kept on log sheets for soil and groundwater.

5.10 Site Management and Base Support

Throughout the investigation activities, work on the CNC will be coordinated through SOUTHDIV and SCDHEC.

The primary contacts for each are as follows:

1. SOUTHDIV point of contact
Gabe Magwood
Southern Division Engineering Command
2155 Eagle Drive
North Charleston, SC 29406
(843) 820-7307
2. SOUTHDIV point of contact
Tony Hunt
Southern Division Engineering Command
2155 Eagle Drive
North Charleston, SC 29406
(843) 820-5525
3. SCDHEC point of contact
Chuck Williams
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
(843) 898-4339

REFERENCES

Ensafe/ Allen & Hoshall. July, 1996. Comprehensive Sampling and Analysis Plan.

Parsons Engineering Science, Inc. and United States Geological Survey. September 1998. Technical Guidelines for Evaluating Monitored Natural Attenuation of Petroleum Hydrocarbons and Chlorinated Solvents in Ground Water at Naval and Marine Corps Facilities.

South Carolina Department of Health and Environmental Control. 1997. Corrective Action Guidance.

Tetra Tech NUS, Inc.; 2000 Rapid Assessment for Zone E/Site 27 (Building 221), Charleston, South Carolina.

United States Environmental Protection Agency. 1990. Code of Federal Regulations 136.

United States Environmental Protection Agency. 1988. EPA Users Guide to Contract Laboratory Program.

United States Environmental Protection Agency. 1996. EPA Environmental Investigations Standard Operating Procedures for Quality Assurance Manual.

TABLE 1
GROUNDWATER ELEVATIONS
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL BASE COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well #	Total Depth of Well (ft)	Top of Casing Elevation, ft (MSL)	Date Measured	Depth to Water, ft (BTOC)	Depth to Product, ft (BTOC)	Product Thickness (ft)	Groundwater Elevation (MSL)
CNC27M-01	11.68	7.85	9/23/1999	1.99	ND	ND	5.86
CNC27X-03	12.43	8.14	9/23/1999	2.24	ND	ND	5.90
CNC27X-04	12.41	8.09	9/23/1999	2.33	ND	ND	5.76
CNC27X-04D	39.62	8.39	9/23/1999	5.54	ND	ND	2.85
CNC27X-05	12.40	8.22	9/23/1999	3.22	ND	ND	5.00
CNC27X-07	13.16	8.34	9/23/1999	3.32	ND	ND	5.02

Notes:

MSL - Mean Sea Level

BTOC - Below Top of Casing

ND- Not Detected

ft - Feet

TABLE 2
GROUNDWATER FIELD MEASUREMENTS
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well I.D.	Date Sampled	Purge method	Volume (gallons)	Temp. (° C)	pH	Specific Conductivity (uMHOS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)
CNC27M-01	9/23/1999	PP	2.50	26.1	7.19	0.304	-10	1.34
CNC27X-03	9/23/1999	PP	6.00	27.3	8.94	0.671	10	0.52
CNC27X-04	9/23/1999	PP	4.83	27.2	7.17	0.553	12	1.99
CNC27X-04D	9/23/1999	PP	4.80	23.2	6.74	1.480	14	1.58
CNC27X-05	9/23/1999	PP	4.41	25.7	6.57	0.610	12	2.46
CNC27X-07	9/23/1999	PP	4.00	28.2	6.93	0.761	11	1.53

Notes:

(° C) - Degrees Celsius

PP - Peristaltic pump, low flow technique

uMHOS/cm - Micro HOS per centimer

NTU - Nephelometric turbidity units

mg/l - milligrams per liter

TABLE 3

GROUNDWATER NATURAL ATTENUATION FIELD MEASUREMENTS
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well I.D.	Date Sampled	Dissolved Oxygen (mg/l)	Alkalinity (mg/l)	Carbon Dioxide (mg/l)	Sulfide (mg/l)	Ferrous Iron (mg/l)	Nitrite (mg/l)	Manganese (mg/l)	Nitrogen/Nitrate* (mg/l)	Sulfate* (mg/l)
CNC27M-01	9/23/1999	0.40	241	212	0.02	0.03	0.081	0.1	<0.050	16
CNC27X-05	9/23/1999	3.00	203	203	0.02	3.30	0.042	0.5	<0.050	92
CNC27X-07	9/23/1999	1.00	343	230	0.02	1.70	0.044	0.0	<0.050	<1.0

Notes:

mg/l - Milligrams per liter

NA - Not Analyzed

* Fixed base laboratory analysis

TABLE 4

**SUMMARY OF OVA SOIL SCREENING RESULTS
SITE 27, BUILDING 221
ZONE E, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA**

Sample Location	Sample Identification	Sample Depth (feet)	Total Organic Vapor Headspace Concentration
CNC27-B01	27SSB0104	0-4	0
	27SSB0107	4-7	(>5000 PPM IN BOREHOLE)
CNC27-B02	27SSB0202	0-2	500
	27SSB0207	4-7	(>5000 PPM IN BOREHOLE)
CNC27-B03	27SSB0302	0-2	0
	27SSB0304	2-4	0
CNC27-B04	27SSB0404	0-7	No Recording
CNC27-B05	27SSB0504	0-4	0
CNC27-B06	27SSB0601	1-4	No Recording
CNC27-B07	27SSB0701	1-5	No Recording

Notes:

OVA - organic vapor analyzer equipped with a flame ionization detector

PPM - Parts Per Million

TABLE 5

SUMMARY OF MOBILE LABORATORY SCREENING RESULTS FOR SOIL
SITE 27, BUILDING 221
ZONE E, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Sample Depth (feet)	Laboratory Screening Data ⁽¹⁾					
			Benzene (µg/Kg)	Toluene (µg/Kg)	Ethylbenzene (µg/Kg)	Total Xylenes (µg/Kg)	Naphthalene (µg/Kg)	Diesel Range Organics (mg/Kg)
CNC27-B01	27SFB070102	1-2	ND	ND	ND	ND	ND	ND

NOTES:

⁽¹⁾ Laboratory screening data was analyzed using USEPA Method 8020/8015M. Compounds not detected are reported as less than the instrument detection limit.

µg/Kg = micrograms per kilogram

mg/Kg = milligrams per kilogram

TABLE 6

**SUMMARY OF MOBILE LABORATORY SCREENING RESULTS FOR GROUNDWATER
SITE 27, BUILDING 221
ZONE E, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA**

Sample Location	Sample Identification	Sample Depth (feet)	Laboratory Screening Data ⁽¹⁾					Diesel Range Organics (mg/L)
			Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylenes (µg/L)	Naphthalene (µg/L)	
CNC27-B01	27GFB010407	4-7	ND	ND	ND	ND	28	ND
CNC27-B02	27GFB020407	4-7	ND	ND	ND	ND	ND	ND
CNC27-B03	27GFB030407	4-7	ND	ND	ND	ND	17	ND
CNC27-B04	27GFB040407	4-7	ND	ND	ND	ND	ND	ND
CNC27-B05	27GFB050407	4-7	ND	ND	ND	ND	ND	ND
CNC27-B06	27GFB060204	2-4	ND	ND	ND	ND	ND	ND
CNC27-B07	27GFB070304	3-4	ND	ND	ND	ND	ND	ND

NOTES:

⁽¹⁾ Laboratory screening data was analyzed using USEPA Method 8020/8015M. Compounds not detected are reported as less than the instrument detection limit.

µg/L = micrograms per liter

mg/L = milligrams per liter

TABLE 7

**SUMMARY OF FIXED-BASE LABORATORY ANALYTICAL RESULTS FOR CHEMICALS OF CONCERN IN SOIL
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA**

Soil Boring / Sample No.	Sample Date	Benzene (ug/kg)	Toluene (ug/kg)	Ethyl- benzene (ug/kg)	Xylenes (total) (ug/kg)	Benzo(a) anthracene (ug/kg)	Benzo(b) fluoranthene (ug/kg)	Benzo(k) fluoranthene (ug/kg)	Chrysene (ug/kg)	Dibenzo(a,h) anthracene (ug/kg)	Naphthalene (ug/kg)
RBSL ⁽¹⁾		5	1622	1260	42471	73084	29097	231109	12998	87866	210
CNC27-B07 / 27SLB0701	12-Oct-99	< 5	< 5	< 5	< 5	< 355	< 355	< 355	< 355	< 355	< 5

All concentrations are in micrograms per kilograms (ug/kg).

⁽¹⁾ South Carolina Department of Health and Environmental Control Risk Based Screening Levels for sandy soils; depth to groundwater less than 5 feet.

TABLE 8

**SUMMARY OF FIXED-BASE LABORATORY ANALYTICAL RESULTS FOR CHEMICALS OF CONCERN IN GROUNDWATER
SITE 27, BUILDING 221
ZONE E CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA**

Monitoring Well/ Sample No.	Sample Date	Benzene (ug/L)	Ethyl- benzene (ug/L)	Toluene (ug/L)	Xylenes (total) (ug/L)	Naphthalene (ug/L)	Benzo(a) anthracene (ug/L)	Benzo(b) fluoranthene (ug/L)	Benzo(k) fluoranthene (ug/L)	Chrysene (ug/L)	Dibenzo(a,h) anthracene (ug/L)	MTBE (ug/L)
RBSL ⁽¹⁾		5	700	1000	10,000	10 ⁽²⁾	10 ⁽²⁾	10 ⁽²⁾	10 ⁽²⁾	10 ⁽²⁾	10 ⁽²⁾	40
CNC27M-01 / 27GLM0101	23-Sep-99	< 5	< 5	< 5	< 5	< 5	< 11	< 11	< 11	< 11	< 11	< 5
CNC27M-01 / 27GLM0101D	23-Sep-99	< 5	< 5	< 5	< 5	< 5	< 11	< 11	< 11	< 11	< 11	< 5
CNC27X-03 / 27GLX0301	23-Sep-99	< 5	< 5	< 5	< 5	17	< 11	< 11	< 11	< 11	< 11	< 5
CNC27X-04 / 27GL0401	23-Sep-99	< 5	< 5	< 5	< 5	7	< 11	< 11	< 11	< 11	< 11	< 5
CNC27X-4D / 27GL4D01	23-Sep-99	< 5	< 5	< 5	< 5	< 5	< 11	< 11	< 11	< 11	< 11	< 5
CNC27X-05 / 27GLX0501	23-Sep-99	< 5	< 5	< 5	< 5	< 5	< 11	< 11	< 11	< 11	< 11	< 5
CNC27X-07 / 27GLX0701	23-Sep-99	< 5	< 5	< 5	< 5	< 5	< 11	< 11	< 11	< 11	< 11	< 5

All concentrations are in ug/L (micrograms per Liter).

⁽¹⁾ South Carolina Department of Health and Environmental Control Risk Based Screening Levels for ground water.

⁽²⁾ The Risk based screening level for individual PAH CoC is 10 ug/l or 25 ug/l for total PAHs.

TABLE 8 - Continued

**SUMMARY OF FIXED-BASE LABORATORY ANALYTICAL RESULTS FOR CHEMICALS OF CONCERN IN GROUNDWATER
SITE 27, BUILDING 221
ZONE E CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA**

Monitoring Well/ Sample No.	Sample Date	Lead (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Cadmium (ug/L)	Total Chromium (ug/L)	Mercury (ug/L)	Selenium (ug/L)	Silver (ug/L)
RBSL ⁽¹⁾		15	50	2000	5	100	2	50	5
CNC27M-01 / 27GLM0101	23-Sep-99	42.5	12.6	55.1	< 2.1	< 11.4	< 0.09	< 2.57	< 2.54
CNC27M-01 / 27GLM0101D	23-Sep-99	17.5	8.4	47	< 1.94	< 4.6	< 0.04	< 2.57	< 2.54
CNC27X-03 / 27GLX0301	23-Sep-99	675	9.4	19.9	< 0.34	133	0.34	< 2.57	< 2.54
CNC27X-04 / 27GL0401	23-Sep-99	< 1.09	< 3.8	19.9	< 1.94	< 4.31	< 0.02	< 2.57	< 2.54
CNC27X-4D / 27GL4D01	23-Sep-99	< 1.09	31.8	65.4	< 1.94	< 4.31	< 0.02	< 2.57	< 2.54
CNC27X-05 / 27GLX0501	23-Sep-99	< 4.9	16.3	17	< 1.94	< 4.31	< 0.02	< 2.57	< 2.54
CNC27X-07 / 27GLX0701	23-Sep-99	< 2.2	< 4.3	80.3	< 1.94	< 4.31	< 0.02	< 2.57	< 2.54

All concentrations are in ug/L (micrograms per Liter).

⁽¹⁾ South Carolina Department of Health and Environmental Control Risk Based Screening Levels for ground water.

TABLE 9

FATE AND TRANSPORT INPUT PARAMETERS
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Parameter	Domenico Dilution/Attenuation Model ⁽¹⁾
Hydraulic Conductivity [m/sec]	1.17E-04
Hydraulic Gradient [ft/ft]	0.0124
Porosity [cm ³ /cm ³]	0.47
Estimated Plume Length [ft]	NA
Soil Bulk Density(a) [g/cm ³]	1.45
Partition Coefficient [L/kg]	chemical specific
Fraction of Organic Carbon in soil [g/g]	1.75E-03
First Order Decay Rate [sec-1]	0
Modeled Plume Length [ft]	NA
Modeled Plume Width [ft]	NA
Source Width(b) [m]	15
Source Thickness(b) [m]	2
Soluble Mass [kg]	Infinite ⁽²⁾

Notes:

(1) - *South Carolina Risk-Based Corrective Action for Petroleum Releases*,
South Carolina Department of Health and Environmental Control, 1998.

(2) - Default value

TABLE 10

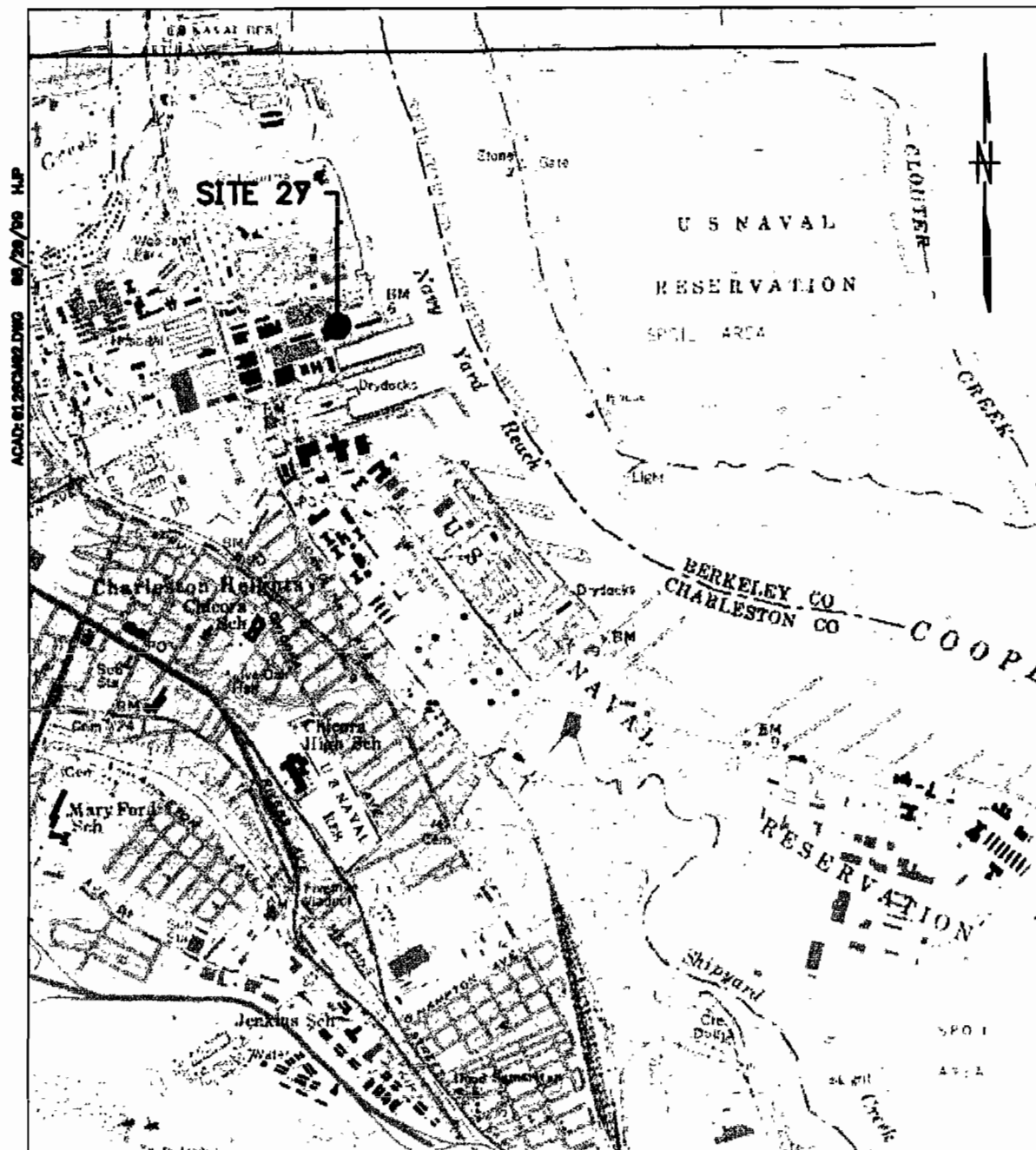
**EXPOSURE PATHWAY ASSESSMENT - CURRENT USE
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA**

Media	Exposure Route	Pathway Selected for Evaluation? (Yes or No)	Exposure point or Reason for Non-Selection	Data Requirements (if pathway selected)
Air	Inhalation	No	No volatilization to enclosed space. No explosion hazard.	
	Explosion Hazard	No		
Groundwater	Ingestion	No	No water supply well downgradient or residential basements.	
	Dermal contact	No		
	Inhalation	No		
Surface Water	Ingestion	No	Cooper River approximately 600 feet downgradient. No completed pathway.	No additional data required
	Dermal contact	No		
	Inhalation	No		
Surficial Soil	Ingestion	No	No impacted surface soil	
	Dermal contact	No		
	Inhalation	No		
Subsurface Soil	Ingestion	No	No current complete pathway.	
	Dermal contact	No		
	Inhalation	No		
	Leaching to Groundwater	No		

TABLE 11

EXPOSURE PATHWAY ASSESSMENT - FUTURE USE
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Media	Exposure Route	Pathway Selected for Evaluation? (Yes or No)	Exposure point or Reason for Non-Selection	Data Requirements (If pathway selected)
Air	Inhalation	No	No volatilization to enclosed space. No explosion hazard.	
	Explosion Hazard	No		
Groundwater	Ingestion	Yes	Future use of property expected to be industrial or commercial. Underground utility lines within close proximity to the site; therefore, construction worker exposure possible.	No additional data required
	Dermal contact	Yes		
	Inhalation	Yes		
Surface Water	Ingestion	Yes	Cooper River 600 feet downgradient. Ingestion is considered the most conservative pathway therefore the only one analyzed.	No additional data required
	Dermal contact	No		
	Inhalation	No		
Surficial Soil	Ingestion	No	No impacted surface soil.	
	Dermal contact	No		
	Inhalation	No		
Subsurface Soil	Ingestion	No	No impacted subsurface soil.	
	Dermal contact	No		
	Inhalation	No		
	Leaching to Groundwater	No		



SOURCE: QUADRANGLE MAP SOUTH CAROLINA, REVISED 1979
QUADRANGLE MAP NORTH CHARLESTON REVISED, 1979

0 2000 4000
SCALE IN FEET

DRAWN BY DATE
HJP 8/20/99

CHECKED BY DATE

COST/SCHED-AREA

SCALE
AS NOTED



SITE LOCATION MAP
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

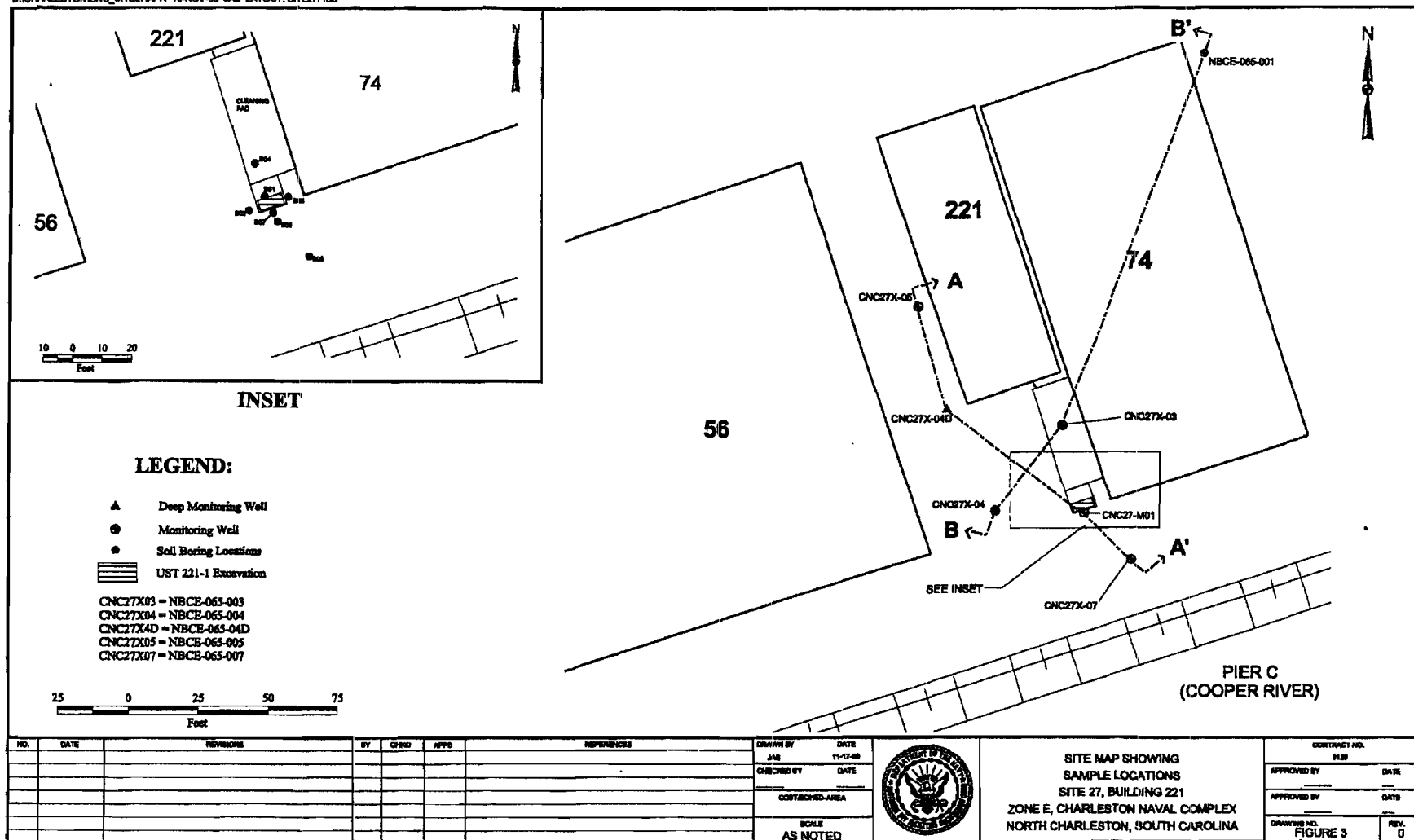
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APPROVED BY DATE

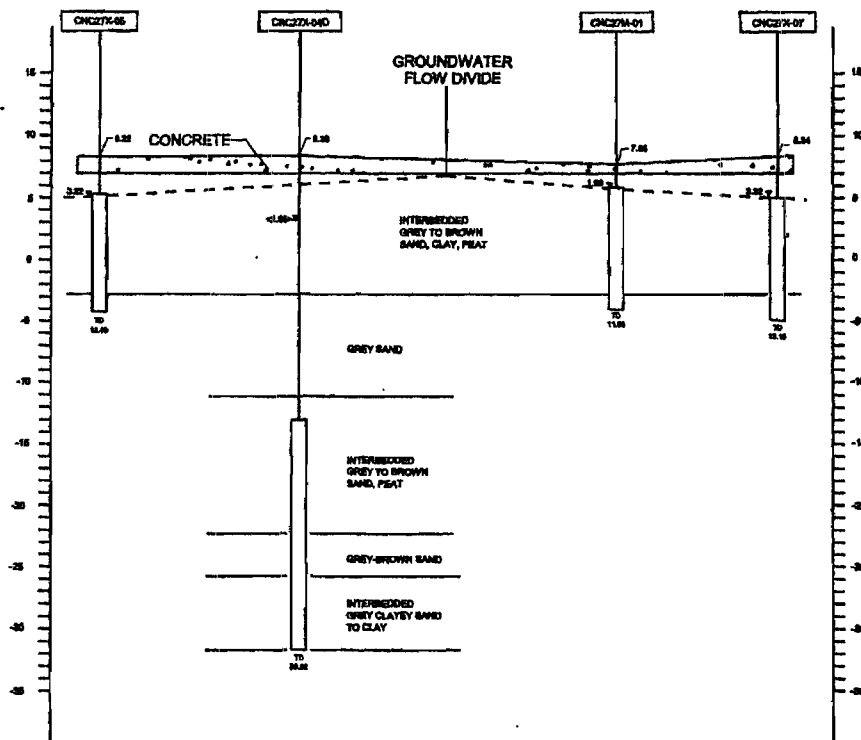
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FIGURE 1

REV.
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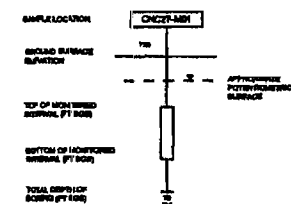


A
NORTHWEST

A'
SOUTHEAST



LEGEND



NOTES:

NO-NO DATA
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
(FT AMSL)



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY	DATE
JAS	11-17-99
CHECKED BY	DATE
CONTROLLED BY	DATE
SCALE	AS NOTED

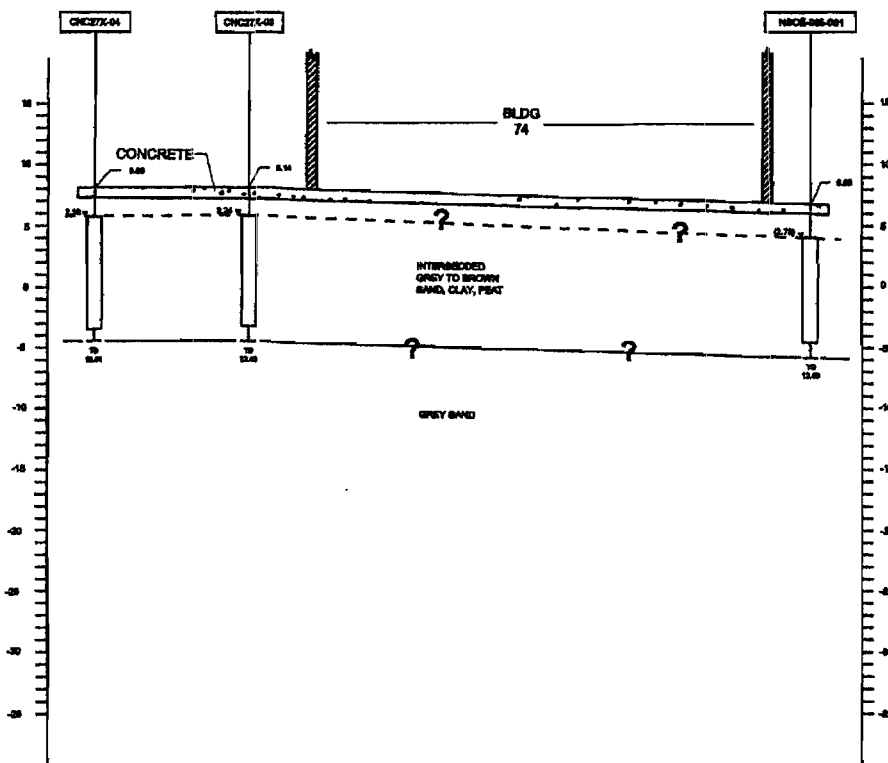


GEOLOGIC CROSS SECTION A - A'
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

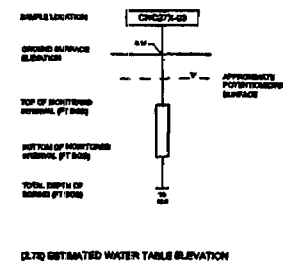
CONTRACT NO.	FIG 4
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO.	FIGURE 4
REV.	0

B
NORTHEAST

B'
SOUTHWEST



LEGEND

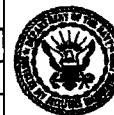


NOTES:

ND=NO DATA
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
(FT AMSL)



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES	DRAWN BY	DATE	CONTRACT NO.
							JAS	11-18-88	0128
							CHECKED BY	DATE	APPROVED BY
							CONTINUED AREA		DATE
							SCALE		APPROVED BY
							AS NOTED		DATE
									DRAWING NO.
									FIGURE 5
									REV.
									0



GEOLOGIC CROSS SECTION B - B'
SITE 27, BUILDING 221
ZONE E, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

